Original Article - Comparative Study

Six-hole versus Four-hole Miniplates in Isolated, Unilateral Angle Fracture of the Mandible

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Abstract

Aim: The aim of the study was to find the suitable situation for the fixation of "six" hole miniplates in open reduction and internal fixation of displaced and nondisplaced unilateral angle of the mandible fractures. **Subjects and Methods:** Displaced, nondisplaced, simple, compound (linear and noncomminuted) isolated unilateral angle fractures with or without occlusal derangement were included in this study. **Statistical Analysis Used:** Chi-square test was used for the statistical analysis. **Results:** The parameters assessed preoperatively and postoperatively were mouth opening, occlusion, neurosensory deficit such as paresthesia, intraoperative time, stability of fragments, and access to the retromolar trigone which showed that the six-hole titanium miniplate was clinically useful in special clinical situations when compared to four-hole titanium miniplate. **Conclusion:** To conclude, six-hole titanium miniplate was clinically useful when compared to four-hole titanium miniplate in the following special clinical situations such as bone loss following extraction of third molar, no posterior occlusion and instability of fracture moderately displaced fracture needs more stability.

Keywords: Angle fractures, internal fixation, open reduction, six-hole titanium miniplates

Introduction

The objective of the study was to find the suitable situation for fixation of "six" hole miniplates in open reduction and internal fixation (ORIF) of displaced and nondisplaced unilateral angle fractures of the mandible. All the patients were briefed about the surgical procedures and its postoperative sequelae, and informed consent both in English and the regional language was obtained before the commencement of the study. The surgical procedures and its consequences were documented and patients were fully informed of the possible advantages and disadvantages of treatment options. The study was approved by the institutional ethical committee before the treatment started.

Subjects and Methods

Inclusion criteria

Displaced, nondisplaced, simple, compound (linear and noncomminuted) isolated unilateral angle fractures with or without occlusal derangement with some cases of infection of angle of the mandible were also included in this study. All healthy individuals selected between 20 and 45 years of both sexes with dentulous conditions and patients willing for a follow-up for at least 3 months were included in the study.

Exclusion criteria

Severely comminuted fractures, mandibular fractures other than the fracture of the angle associated with midfacial fractures, and medically compromised patients were excluded from this study.

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Sample size

The sample size of this study was twenty patients (ten in each group). The required armamentarium for the surgical procedure was arranged [Figure 1].

Patients were divided into two groups as follows:

- Group 1: In this group, the patients were treated with a single (2 mm) four hole titanium miniplate with gap and four 2 mm × 8 mm titanium screws [Figure 2]
- Group 2: In this group, the patients were treated with single (2 mm) six hole titanium miniplate with gap and six 2 mm × 8 mm titanium screws [Figure 3].

Surgical procedure

All the patients with isolated unilateral angle of the mandible fractures were treated with Champy's miniplate osteosynthesis under local anesthesia [Figures 4-7]. Eyelets and Erich's Arch bars were placed and occlusion was achieved through maxillomandibular fixation [Figures 8 and 9]. Fracture site was exposed via intraoral incisions along the anterior border of ramus in cases where the third molars were retained [Figures 10 and 11]. In cases where the need for the removal of the third molars arose, modified Ward's incision was placed to expose the fracture site. Care was taken while raising the mucoperiosteal flap on the lingual side to avoid damage to the lingual nerve. The exposed angle fracture of the mandible was reduced to anatomical alignment with perfect occlusion and fixed by a single 2 mm four-hole titanium miniplate with gap and four 2 mm × 8 mm titanium screws in superior border along external oblique ridge in Group 1 patients [Figure 12] and single 2 mm 6-hole titanium miniplate with gap and six 2 mm × 8 mm titanium screws in superior border along external oblique ridge in Group 2 patients [Figure 13]. The maxillomandibular fixation (MMF) was released temporarily to place the last screw caudally (superiorly) in the proximal segment, especially in Group 2 patients. The adaptability and the stability of the plate along the fracture line were assessed by clinical observation [Figures 14 and 15]. Hemostasis were obtained and the wound were sutured. Post operatively occlusion were achieved [Figure 16 and 17]. Both the groups of patients were kept under postoperative MMF for a period of 2 weeks and reviewed periodically. Pressure bandage was applied on the lateral aspect of angle in all patients to substantially minimize the postoperative edema. All the patients were administered systemic antibiotics for 5 days. Postoperative instructions were given on maintenance of oral hygiene using chlorhexidine mouthwash for 2 weeks [Figures 16 and 17]. The patients were advised to take soft, preferably a semisolid diet. The entire clinical and radiological parameters were followed for 3 months at 1st week [Figures 18 and 19], 3rd week [Figures 20 and 21], and 3 months [Figures 22 and 23].

Results

Twenty patients with isolated angle of the mandible fracture were included in the study. Patients presented with chief complaints of inability to open the mouth, swelling of the face, deranged occlusion, inability to close the mouth, and mobility of segments. The patients were divided into two groups, each containing ten patients. Majority of the patients were male constituting nearly 90%. In 80% of cases, the

Figure 1: Armamentarium

Figure 2: Titanium 2mm 4-hole plate Group 1

Figure 3: Titanium 2mm 6-hole plate Group 2

Figure 4: Group 1 preoperative occlusion

Figure 5: Group 2 preoperative occlusion

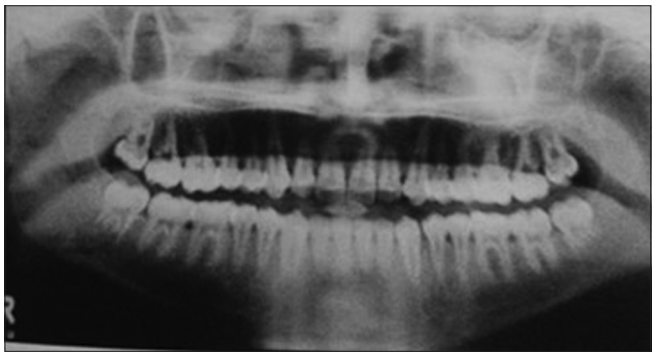

Figure 6: Group 1 preoperative orthopantomogram showing right side angle of mandible fracture

Figure 7: Group 2 preoperative orthopantomogram showing displaced left angle fracture of mandible

Figure 8: Group 1 intermaxillary fixation eyelet wiring

Figure 9: Group 2 intermaxillary fixation Erich's arch bar wiring

angle fracture was on the right side; the post traumatic swelling was present in 70% of cases. The etiology of trauma was road traffic accidents in 19 patients and assault in one case. The angle fractures were minimally and moderately displaced in 70% of the patients and nondisplaced in 30% of the patients. The third molars were involved in 50% of the cases and required extraction of the tooth due to fracture of the crown with pulp exposure and mobile teeth in the fracture line. The parameters assessed both preoperatively and postoperatively were mouth opening, occlusion, bite force on the molar region, and neurosensory deficit such as paresthesia. Intraoperatively, the parameters assessed were intraoperative time, stability of fragments, and access to the retromolar trigone during the last screw placement and adaptability of the titanium miniplates on the bone contour. In all these patients, it is observed that there is a gradual improvement in the mouth opening after open reduction with internal fixation with a follow-up period of 3 months [Table 1].

There is a significant improvement in the masticatory efficiency of the Group 1 individuals than Group 2

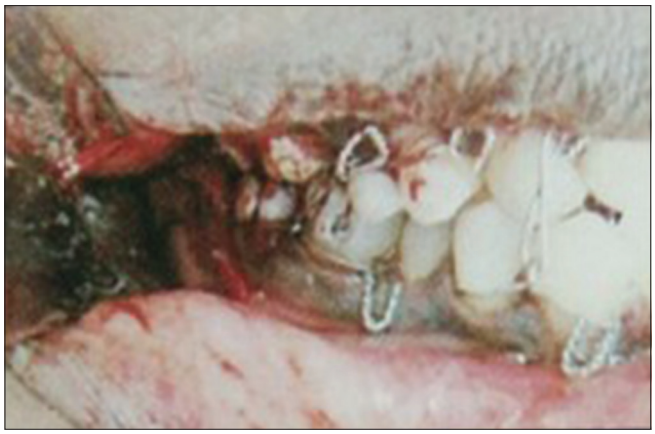

Figure 10: Group 1 incision and surgical exposure

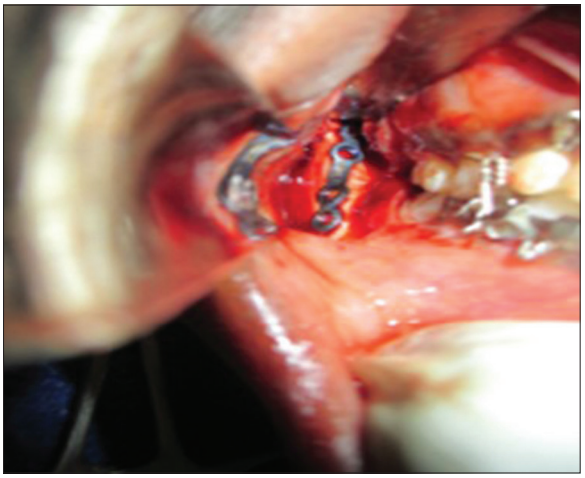

Figure 12: Group 1 four-hole titanium miniplates with gap intraoral adaptation

Figure 14: Group 1 four-hole titanium plate fixation

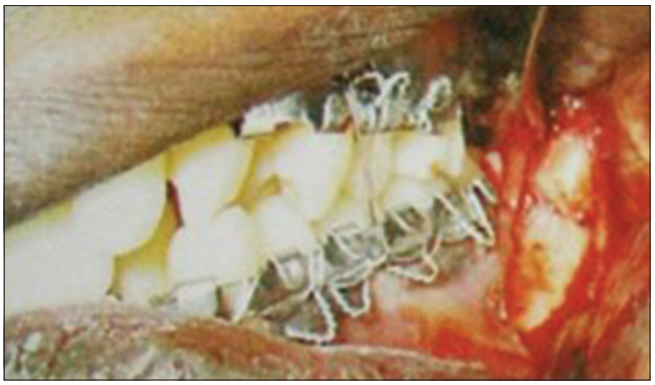

Figure 11: Group 2 incision and surgical exposure

Figure 13: Group 2 six-hole titanium mini plate with gap intraoral plate adaptation

Figure 15: Group 2 six-hole titanium plate fixation

individuals after the surgical management following bite force evaluation [Table 2].

All patients with neurosensory deficits were advised methylcobalamin twice daily for 3 months during the postoperative period. At the end of the 3rd month, both Group 1 and Group 2 patients showed considerable improvement, with some cases of neurosensory deficits [Table 3].

The adaptability of the titanium miniplates in both the groups were assessed with the aid of orthopantomogram by visualizing the interface between the bone contour and the plates, and the interfragmentary approximation and stability of the titanium miniplates in both the groups were assessed clinically. Care taken to adapt the titanium plates to the angle of the mandible

Figure 16: Group 1 postoperative occlusion

Figure 17: Group 2 postoperative occlusion

Figure 18: Group 1 postoperative orthopantomogram – 1 week

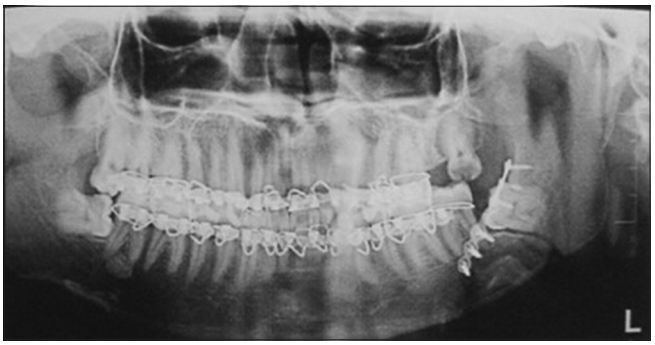

Figure 19: Group 2 postoperative orthopantomogram – 1 week

Figure 20: Group 1 postoperative orthopantomogram – 3 weeks

Figure 21: Group 2 postoperative orthopantomogram – 3 weeks

Figure 22: Group 1 postoperative orthopantomogram – 3 months

Figure 23: Group 2 postoperative orthopantomogram – 3 months

proved to yield good results in the stability of the fragments [Table 4].

The stability of fragments were assessed intraoperatively by manually checking for any interfragmentary mobility of the

Table 1: Mouth opening in mm

Group 1		Group 2	
Mouth opening in mm		Mouth opening in mm	
Preoperative	Postoperative 3rd month	Preoperative	Postoperative 3rd month
16	35	15	43
15	35	23	35
28	50	24	40
20	50	13	35
28	45	15	45
20	40	15	45
18	53	17	46
27	42	27	46
14	45	28	40
25	40	20	43

Table 2: Bite force

Group 1 Score				Group 2 Score			
Preoperative		Postoperative 3rd month		Preoperative		Postoperative 3rd month	
Affected site	Unaffected site	A	UA	A	UA	A	UA
0.8	1	4.0	37	1.3	2	34.5	38
0.4	1	34.8	37	1.4	1	35.6	38
0.8	3	35	40	2.8	4	36	40
1.4	2	34	38	2.0	2	36	38
1.5	2	35	44	1.4	3	52	38
6.6	12	52	40	1.4	2	35.6	44
6.5	7	28	58	0.6	1	38	42
2.4	3	43	37	0.8	2	38	40
11.4	12	38	46	3.2	10	35	40
2.4	1	35	43	2.6	4	45	54

UA=U - Unaffected site, A - Affected site

Table 3: Neurosensory deficit

Group 1		Group 2	
Paraesthesia		Paraesthesia	
Preoperative	Postoperative 3rd month	Preoperative	Postoperative 3rd month
Yes	Yes	Yes	Yes
No	No	No	No
No	No	Yes	No
No	No	Yes	No
No	No	Yes	No
No	No	Yes	No
No	No	Yes	No
No	No	Yes	No
No	No	No	No
No	No	No	No

segments after internal fixation. Clinically and radiologically, it has been found that the stability of the fractured fragments has improved well after open reduction with internal fixation [Table 5].

The accessibility to the retromolar trigone was critically evaluated in both the groups during the surgical procedure. It has been observed interestingly that there was difficulty in Group 2 patients since the six-hole titanium miniplate with gap was extending caudally (superiorly) in the proximal segment which caused difficulty of placing the last screw in the proximal segment when the patient was in MMF, so intermaxillary fixation were released, then with the jaw in partial open mouth position, the last two screws were placed. In four hole with gap titanium miniplate, no such difficulties were encountered [Table 6].

Occlusion was assessed preoperatively and postoperatively [Table 7].

Patients with wound infection in both the groups were treated with appropriate antibiotics [Table 8].

Discussion

The most frequent site in the mandible to be fractured in case of an isolated fracture is the angle region. The angle fractures of the mandible were more common in males and in the second and third decades in the present study, which correlated with the other studies. In the reported study, 90% of the angle fractures were due to road traffic accidents. This is in contrast with most of the reports from the Western countries where assault was found to be the common cause. A study done by Subhashraj assessed the impact of mandibular third molars on mandibular angle fractures.[1] The study confirmed that there was an increased risk of angle fracture depending on the position of the third molars. It was found that angle fractures were more often involved in patients with completely or partially impacted third molars. This similar finding was noted in the current study. However, few authors showed that superficially impacted third molars were associated with an increased risk of angle fracture than deeply impacted third molars. This is in accordance with the biomechanical study by Meisami *et al*. which suggested that the strength of the mandible is derived from the maintenance of cortical and not medullary bone integrity.[2] Since the superficially located third molars disrupt the cortical integrity of the external oblique ridge, it producing a point of weakness, and hence, increasing the risk of fracture. The presence of lower third molars make the mandibular angle two to three times more likely to fracture. However, in the present study, it was noted that the presence of deeply impacted third molars increased the incidence of mandibular angle fractures compared to superficially located third molars. Mobile, infected, and fractured teeth and teeth which interfered with the reduction of fractures were removed in this reported study. According to the "Finite element method," tensile stress develops at the superior border and compression forces generated at the inferior border when stress distribution is in anterior mandibular loading. On the other

Table 4: Adaptability of plates: (intraoperatively) Score: 1 - not satisfactory; 2 - good; 3 - very good

Score	
Group 1	**Group 2**
1	1
1	3
1	2
2	3
2	3
2	3
2	3
2	3
3	3
2	3

Table 5: Stability of fragments: (intraoperatively). Score: 1 - not satisfactory; 2 - good; 3 - very good

Score	
Group 1	**Group 2**
3	1
2	2
2	2
2	3
2	3
2	3
2	3
2	3
2	3
3	3

Table 6: Access to retromolar trigone: (intraoperatively). Score: 1 - not satisfactory; 2 - good; 3 - very good

Score	
Group 1	**Group 2**
2	1
2	2
2	2
2	2
3	3
2	2
3	3
3	3
3	3
3	3

hand, stress distribution in the posterior mandibular loading results in compressive forces at superior border and tension at the inferior border. Numerous complications up to 32% can be related with angle fractures in the form of infection, malunion, malocclusion, and facial nerve damage, whereas the Champy technique was associated with fewer complications, in contrary to other adopted techniques. Relatively thin cross-sectional area within the angle and the presence of third molar result in relatively high incidence (27%–30%) of angle fractures among mandibular fractures. Champy *et al*. suggested the use of single noncompression miniplate on the superior border of the mandibular angle fractures because absolute rigid fixation was not mandatory for the healing of the same.[3] Kumar *et al*. found no significant differences in outcomes (or) complications between internal fixation with immediate release and internal fixation with 5–7 days of MMF.[4] However, postoperative MMF still seems to have several advantages, including undisturbed healing of the intraoral incision, stabilizing the occlusion, and encouraging patients to become accustomed to a liquid diet. The absolute indications for the removal of third molar teeth are as follows: vertical fracture of teeth with pulp exposure; Grade II (or) III mobility due to chronic periodontitis; caries with periapical pathology; and displaced tooth preventing reduction. Miniplate osteosynthesis was first introduced by Michelet *et al*. in 1973 and further developed by Champy *et al*. in 1975 who suggested a single noncompression miniplate along the "ideal line of osteosynthesis" in mandibular angle fracture. Studies have provided evidence that the main reason for infection associated with rigid fixation is the failure to achieve stability even after the placement of plates and screws. For angle fractures, reduction and fixation should be performed as soon as possible to obtain the correct positioning of fracture segment to avoid the sequel. The classical method of fixation proposed by Champy *et al*. in the case of mandibular angle fracture is designed to apply a miniplate at the superior border of the mandible in the area of external oblique line with monocortical screws. Michelet *et al*. was the first to present "miniaturized screwed plate," considered to be the first "prototype" of the modern miniplates.[5] The use of two points of fixation has been found to increase the complication rate as reported by Ellis where he states that "Wherever two points of fixation were used for fractures of the angle, the complication rate was much higher than when one point of fixation was applied."[6] The higher complication rate could be because of greater periosteal and muscle stripping in the angle region, thus compromising the healing and stabilizing action of the muscles. Ellis concluded in his study that the most effective method of fixation was either an extraoral ORIF with the Arbeitsgemeinschaft fuer Osteosynthesefragen - Association for the Study of Internal Fixation (AO/ASIF) reconstruction plate or intraoral ORIF using a single miniplate. Based on this, in the reported study, a single miniplate along the superior border was used in both Group 1 and Group 2 patients. Marisa *et al*. in their study on fixation of mandibular fractures with 2 mm miniplates reported 7.85% incidence of infection, malunion in 1.78%, and paresthesia in one patient.[7] Similarly, in our study, only two patients had wound infection and there was no incidence of any malunion. Kang and Zide in their study on the usage of seven-hole angle plate for mandibular angle fractures suggested the following parameters for the placement of seven-hole angle plate such as failure to reduce

Table 7: Occlusion: Score: 1 - normal; 2 - mild discrepancy; 3 - no occlusion

Group 1 Score		Group 2 Score	
Preoperative	Postoperative 3rd month	Preoperative	Postoperative 3rd month
2	2	2	1
2	2	2	1
2	3	3	1
2	2	2	1
2	2	2	1
2	2	2	1
3	2	2	1
2	2	2	1
2	2	2	1
3	2	2	1

Table 8: Wound infection/dehiscence

Group 1		Group 2	
Preoperative	Postoperative	Preoperative	Postoperative
No	No	No	Yes
No	No	No	No
No	No	No	No
Yes	No	Yes	No
No	Yes	Yes	No
No	Yes	No	No
No	No	No	No
No	No	No	No
No	No	No	No
No	No	Yes	No

or fix using four-hole miniplate technique and secondary fractures, for example, condylar fracture necessitating rehabilitation.[8] The conditions such as bone loss from extraction of third molars involved in the fracture site, difficulty in achieving occlusion with four hole miniplates, diminished bone stock as found in partially edentulous mandible, traumatic bone loss, delayed fracture management, fracture obliquity or instability, infected fractures all of which requires more rigid fixation. Based on the above parameters, six-hole titanium miniplates were used in the following clinical situations in this study to assess stability, adaptability, mobility of fragments, postoperative wound healing, and infection. Even in our study, 1 week of MMF was followed and there was primary bone healing in all the cases, and normal occlusion was achieved in all patients. We found that six-hole titanium miniplate with a gap is superior to four-hole miniplate with gap in special clinical situations such as bone loss following extraction of the third molar and no posterior occlusion following MMF with four hole miniplate fixation and infection of fracture preoperatively requiring more rigid fixation. Studies on the fixation of mandibular angle fracture with 2 mm three-dimensional curved angle strut plate suggested that the strut plate allowed for almost no movement at the superior and inferior borders with minimal torsional and bending forces as opposed to a single plate applied to the superior border. It is reported that when only a single plate is placed at the superior border, torsional, and bending forces usually cause movement along the axis of the plate with buccal or lingual splaying and gap formation at the inferior border, respectively. As the screws in a strut plate are placed in a box configuration on both sides of the fracture rather than on a single line, broad platforms are created that may increase the resistance to torsional forces along the axis of the plate. The greater resistance to splaying of the inferior border with a strut plate is because of the strut plate which is conceptually two linear plates connected by a reinforcing vertical strut. In contrary to the above study in both the four-hole and six-hole miniplates used in Group 1 and Group 2 patients in this study, no buccal or lingual splaying or gap formation at the inferior border was noted in the reported study. In our study, preoperatively, there was wound infection in three patients in Group-2 and one patient in Group 1; postoperatively, uncomplicated wound healing was seen in 85% of the patients. The reason for applying MMF is to immobilize the mandible until the soft-tissue incision has healed. Some surgeons use postsurgical MMF to "settle" the occlusal relationship after the application of the bone plate. In the reported study, we have also placed the patient in MMF for 1 week for these above-mentioned reasons. Unfortunately, many of our patients did not present for treatment until days after their injury. Due to this, our patients were treated on an average of 7 days after the injury. We could detect no difference in complication rates for those fractures treated early or late. Gerlach and Schwarz reported a biting force of 148 N at 6 weeks postoperatively.[9] In the present study, the biting forces achieved in the affected side of Group 2 patients postoperatively were 34.2 ± 13.0 kg (335.502 ± 127.53 N) in a 3-month follow-up. Therefore, this study proves a profound increase in masticatory efficiency in Group 2 patients.

Conclusion

To conclude, the six-hole titanium miniplate is clinically useful when compared to four-hole titanium miniplate in the following special clinical situations such as bone loss following extraction of the third molar, no posterior occlusion and instability of fracture both following four-hole miniplate fixation, and moderately displaced fracture needing more stability.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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